REMARKS

The 21 March 2002 official action addressed claims 2-3 and 5-10. Claims 2-3 and 5-10 and amended and new claims 11-18 are added. Claims 2-3 and 5-18 are pending for reconsideration.

Claim amendments

All of the prior claims (claims 2-3 and 5-10) are amended to more specifically recite that cameras produce images of an object from different viewing angles, and that the images have different resolutions such that pixel units of the images are different in the amount of object represented thereby. All of the prior claims are further amended to indicate that at least one image is converted such that the pixel units of all images represent the same amount of the object. The prior claims are further amended to more clearly recite that a distance is calculated using triangulation (eliminating use of the equivalent term "stereo imaging" as previously recited).

In addition, claims 5, 6, 9 and 10 are amended to more clearly recite that an image is converted by selecting from among a set of samples of the image that are sampled beginning at successive positions in the image (the second embodiment described in the application).

In addition, new claims 11-18 are added. These are dependent claims that recite that the converting performed in claims 2, 3, 5 and 6 involves either sampling of images to reduce their resolution (as described in the first embodiment), or interpolating images to increase their resolution (as described in the third embodiment).

No new matter is added.

Prior art rejection

All claims were rejected under 35 USC §103(a) as being obvious over Auty (U.S. 5,809,161) in view of Subbarao (U.S. 5,193,124).

The claimed invention is not obvious in view of the teachings of Auty and Subbarao. The following presents applicant's positions regarding the cited references.

Teaching of Auty

Auty discloses a system for making detailed images of vehicle license plates. As shown in Figure 1, the system uses a first camera 6 for imaging vehicles at a distance, and a second camera 8 for making a detailed image of a vehicle when it is within a fixed range. The first camera 6 is used to determine when a vehicle is in the range of the second camera 8 so that the second camera 8 can take a high resolution image of the vehicle license plate. The first camera 6 provides periodic images that are used to track the approach of vehicles toward the second camera 8. Auty's system processes the images taken by the first camera 6 to determine when a vehicle is located in the range of the second camera 8 and then instructs the second camera 8 to make an image.

Auty does not perform any conversion on images of the first and second cameras so that their pixel units are equal in the amount of object represented. It is true that Auty performs scaling of images made by the first long range camera 6 (col. 21, line 8). However, nothing in Auty indicates that this scaling is performed with respect to an image made by the second camera 8 so that the pixel units represent equal amounts of object, and there is no reason that such scaling would be performed, since Auty's second camera is not used at all in the tracking of vehicles performed by the first camera. Therefore there is no need for the images of the two cameras to be scaled to have equal pixel units, and that explains why Auty does not teach or suggest performing such scaling.

Auty also does not disclose the concept of computing a distance to an object by triangulation. Auty's vehicle position tracking (col. 7 lines 1-39 and col. 20 line 29 - col. 21 line 63) uses only the image from the long distance

camera 6 and converts the position an object in the image into a position on the X - Y plane of the road surface (Fig. 4) based on the fixed relationship of the camera relative to the road surface. Auty does not use its two cameras to produce two different images of an object so that the distance to the object can be computed by triangulation as claimed.

Therefore, while Auty's system includes two cameras that have different resolutions, this is the only similarity to the claimed invention. Auty's cameras are used in completely different manners for completely different purposes than the claimed invention.

Teaching of Subbarao

Subbarao discloses a system for determining the distance to an object based on focal lengths and aperture settings. Subbarao determines distance by focusing a camera on an object, an then reading the focal length of the camera to determine the distance to the object. Subbarao provides further accuracy by changing the aperture of the camera, which changes the depth of field (i.e. a range behind and in front of the exact focal distance from the lens, within which objects will appear to be in focus) and thus allows Subbarao to determine distance with greater accuracy.

Subbarao's preferred embodiment uses a single camera with switchable lenses that enable the camera to have different focal lengths (Fig. 1, col. 14 lines 33 - 41). In an alternative embodiment, Subbarao's system may use two cameras with two different focal lengths (Fig. 4), however those cameras produce images made from along the same line of sight, not from different viewing angles as claimed. As shown in Figure 4, the light emanating from the object "Scene" is received at a half-silvered mirror, which distributes it to both of cameras 1 and 2. It is clear that the image produced by each of the cameras is produced from exactly the same viewing angle. Imaging along a single line is in fact required for Subbarao's method, since the method measures the distance along that line to the object.

Because Subbarao's system uses only one camera or two cameras that image along the same line of sight, Subbarao does not calculate a distance to an

object by triangulation. Triangulation requires the use of images made from two different visual angles, knowledge of those angles relative to some reference, and knowledge of the distance between the two locations from which the two different visual angles are viewed, so that computations can be made using those angles and distances to determine the distance to the object. In the case of Subbarao, the images are made along exactly the same line, and so there are no angles that can be used to compute distance using triangulation.

It is also noted that Subbarao does not use two cameras having different resolutions such that the pixel units are different in the amount of object represented. Although it has been asserted in past rejections that changes in aperture are related to resolution, those actions simply assert that aperture affects resolution, and do not address the fact that Subbarao does not disclose two cameras having different resolutions such that the pixel units are different in the amount of object represented.

Traversal of the rejection

The present rejection essentially states that if the person of ordinary skill is given the following:

1) a traffic monitoring system that uses a low resolution camera to track an incoming vehicle and a high resolution camera to take its picture when it reaches a certain point; and

2) a distance measuring system that measures distance based on focal length and aperture, using two cameras that make images of the object along a single line of sight,

then it would be obvious to the person of ordinary skill to implement a distance measuring system that makes images of the object from different visual angles using cameras with different resolutions, converts the images so that their pixel units represent the same amount of object, and then processes the images using triangulation to determine a distance to the object.

The proposition is clearly unreasonable, yet this is the basis of the present rejection.

It is well known to patent applicants and patent examiners that the test for obviousness requires a determination of whether the differences between the claimed invention and the teachings of the prior art are such that it would be obvious for one to implement all of those differences based on what is taught in the prior art references. The following table shows the differences between claim 7 (used as an example) and the cited references:

Claim 7	Auty	Subbarao
A three-dimensional structure estimation apparatus which measures a distance to an object, comprising:		
a plurality of cameras for producing images of the object from different viewing angles, the cameras having different resolutions from each other such that pixel units of the images are different in the amount of object represented thereby;		Subbarao uses two cameras for producing images of an object from the same visual angle. Subbarao's pixel units are not different in the amount of object represented thereby. The cameras are the same in all respects except for aperture and focal length.
a conversion unit for converting at least one of the images outputted from said plurality of cameras such that the pixel units of all images are equal in the amount of object represented thereby; and	Auty scales of the image of the first camera but does not say why. The scaling is not done with reference to the image made by the second camera, nothing in Auty indicates that Auty scales to make the pixel units of the first and second cameras the same, and there is no need for Auty to do so.	Subbarao does not convert images so that the pixel units of all images are equal.
a depth image production section for processing the images using triangulation to calculate a distance to the object.	Auty does not calculate a distance to an object using triangulation. Auty determines distance using the image from a single camera.	Subbarao does not calculate a distance using triangulation.

From the table it is seen that the only similarity of either of the references to the present claims is that Auty uses two cameras having different

resolutions. As explained above, those cameras are used in a completely different way for a completely different purpose, and therefore Auty suggests nothing of the presently claimed invention. Subbarao does not teach any of the features of the claimed invention. Therefore there is no explicit suggestion in the cited references that would lead one of ordinary skill to implement all of the differences between the claimed invention and the cited references. Since the differences between the references and the claims are so significant, it would be unreasonable to assert that the suggestion comes from implied but unwritten aspects of the references.

The foregoing remarks address the features of claim 7, and are equally applicable to claim 2 The remaining claims recite additional features in addition to those of claims 2 and 7 that are likewise not taught by the cited references. Claims 3 and 8 recite the additional features of using cameras having different fields and processing those images to have equal pixel units. Claims 5 and 9 recite the additional feature of converting images by selecting from among a set of samples of the image that are taken beginning at successive points of the image. Claims 6 and 10 recite the additional features of both claims 3 and 8 and claims 5 and 9. Claims 11, 13, 15 and 17 recite the feature that images are converted by sampling to reduce their resolution. Claims 12, 14, 16 and 18 recite the feature that images are converted by interpolation to increase their resolution. None of these features is taught or implied by the cited references.

The foregoing amendments and remarks address all bases for objection and rejection and are believed to place the case in condition for allowance. The examiner is invited to contact the undersigned to resolve any remaining issues.

Respectfully submitted,

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PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Gregory HOUSE

Title: THREE DIMENSIONAL STRUCTURE ESTIMATION APPARATUS

Appl. No.: 08/962,315

COPY OF PAPERS ORIGINALLY FILED

Filing Date: 31 October 1997

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Art Unit: 2613

MARKED UP VERSION OF REPLY TO OFFICIAL ACTION OF 21 MARCH 2002 UNDER 37 CFR §1.111

Commissioner for Patents
Washington, D.C. 20231

Sir:

In reply to the 21 March 2002 official action, the application is amended as follows:

In the claims:

2. (Amended Four Times) A three-dimensional structure estimation apparatus which measures a distance to an object, comprising:

a plurality of cameras for producing images of the object from different viewing angles, ~~and~~ the cameras having different resolutions from each other such that pixel units of the images are different in the amount of object represented thereby;

conversion means for converting at least one of the images outputted from ~~each of~~ said plurality of cameras ~~into converted images whose~~such that the pixel units of all images are equal in the amount of object represented thereby; and

a depth image production section for ~~comparing~~ processing the ~~converted~~ images using ~~stereo imaging~~triangulation to calculate a distance to the object.

3. (Amended Four Times) A three-dimensional structure estimation apparatus which measures a distance to an object, comprising:

a plurality of first cameras for producing images of the object from different viewing angles, ~~and~~ the first cameras having different resolutions from each other such that pixel units of the images are different in the amount of object represented thereby;

a plurality of second cameras for producing images of the object from different viewing angles, ~~and~~ the second cameras having different visual fields from each other such that pixel units of the images are different in the amount of object represented thereby;

conversion means for converting at least one of the images outputted from said first cameras and at least one of the images outputted from said second cameras ~~into converted images whose~~ such that the pixel units of all images are equal in the amount of object represented thereby; and

a depth image production section for ~~comparing~~ processing the ~~converted~~ images using ~~stereo imaging~~triangulation to calculate a distance to the object.

5. (Amended Four Times) A three-dimensional structure estimation apparatus which measures a distance to an object, comprising:

a plurality of cameras for producing images of the object from different viewing angles, ~~and~~ the cameras having different resolutions from each other such that pixel units of the images are different in the amount of object represented thereby;

conversion means for converting at least one of the images produced by ~~each of~~ said ~~plurality of~~ cameras ~~into converted images whose~~ such that the pixel units of all images are equal in the amount of object represented thereby, ~~by parallel movement by different movement amounts~~the conversion means converting the at least one image by selecting from among a set of samples of

the at least one image that are sampled beginning at successive positions in the at least one image; and

a depth image production section for ~~comparing~~ processing the ~~converted~~ images using ~~stereo imaging~~triangulation to calculate a distance to the object.

6. (Amended Four Times) A three-dimensional structure estimation apparatus which measures a distance to an object, comprising:

a plurality of first cameras for producing images of the object from different viewing angles, ~~and~~ the first cameras having different resolutions from each other such that pixel units of the images are different in the amount of object represented thereby;

a plurality of second cameras for producing images of the object from different viewing angles, ~~and~~ the second cameras having different visual fields from each other such that pixel units of the images are different in the amount of object represented thereby;

conversion means for converting at least one of the images outputted from said first cameras and at least one of the images outputted from said second cameras ~~into converted images whose~~ such that the pixel units of all images are equal in the amount of object represented thereby, ~~by parallel movement by different movement amounts~~the conversion means converting each of the at least one images by selecting from among sets of samples of each of the at least one images that are sampled beginning at successive positions in each of the at least one images; and

a depth image production section for ~~comparing~~ processing the ~~converted~~ images using ~~stereo imaging~~triangulation to calculate a distance to the object.

7. (Amended Four Times) A three-dimensional structure estimation apparatus which measures a distance to an object, comprising:

a plurality of cameras for producing images of the object from different viewing angles, ~~and~~ the cameras having different resolutions from each other such that pixel units of the images are different in the amount of object represented thereby;

a conversion unit for converting at least one of the images outputted from ~~each of~~ said plurality of cameras ~~into converted images whose~~such that the pixel units of all images are equal in the amount of object represented thereby; and

a depth image production section for ~~comparing~~ processing the ~~converted~~ images using ~~stereo imaging~~triangulation to calculate a distance to the object.

8. (Amended Four Times) A three-dimensional structure estimation apparatus which measures a distance to an object, comprising:

a plurality of first cameras for producing images of the object from different viewing angles, ~~and~~ the first cameras having different resolutions from each other such that pixel units of the images are different in the amount of object represented thereby;

a plurality of second cameras for producing images of the object from different viewing angles, ~~and~~ the second cameras having different visual fields from each other such that pixel units of the images are different in the amount of object represented thereby;

a conversion unit for converting at least one of the images outputted from said first cameras and at least one of the images outputted from said second cameras ~~into converted images whose~~ such that the pixel units of all images are equal in the amount ~~or~~ of object represented thereby; and

a depth image production section for ~~comparing~~ processing the ~~converted~~ images using ~~stereo imaging~~triangulation to calculate a distance to the object.

9. (Amended Four Times) A three-dimensional structure estimation apparatus which measures a distance to an object, comprising:

a plurality of cameras for producing images of the object from different viewing angles, ~~and~~ the cameras having different resolutions from each other such that pixel units of the images are different in the amount of object represented thereby;

a conversion unit for converting at least one of the images produced by ~~each of~~ said ~~plurality of~~ cameras ~~into converted images whose~~ such that the

pixel units of all images are equal in the amount of object represented thereby, ~~by parallel movement by different movement amounts~~the conversion means converting the at least one image by selecting from among a set of samples of the at least one image that are sampled beginning at successive positions in the at least one image; and

a depth image production section for ~~comparing~~ processing the ~~converted~~ images using ~~stereo imaging~~triangulation to calculate a distance to the object.

10. (Amended Four Times) A three-dimensional structure estimation apparatus which measures a distance to an object, comprising:

a plurality of first cameras for producing images of the object from different viewing angles, ~~and~~ the first cameras having different resolutions from each other such that pixel units of the images are different in the amount of object represented thereby;

a plurality of second cameras for producing images of the object from different viewing angles, ~~and~~ the second cameras having different visual fields from each other such that pixel units of the images are different in the amount of object represented thereby;

a conversion unit for converting at least one of the images outputted from said first cameras and at least one of the images outputted from said second cameras ~~into converted images whose~~ such that the pixel units of all images are equal in the amount of object represented thereby, ~~by parallel movement by different movement amounts~~the conversion means converting each of the at least one images by selecting from among sets of samples of each of the at least one images that are sampled beginning at successive positions in each of the at least one images; and

a depth image production section for ~~comparing~~ processing the ~~converted~~ images using ~~stereo imaging~~triangulation to calculate a distance to the object.

11. (New) The apparatus claimed in claim 2, wherein the conversion means samples images such that the pixel units of sampled images represent an

amount of object represented by pixel units of an image having a lowest resolution.

12. (New) The apparatus claimed in claim 2, wherein the conversion means interpolates images such that the pixel units of interpolated images represent an amount of object represented by pixel units of an image having a highest resolution.

13. (New) The apparatus claimed in claim 3, wherein the conversion means samples images such that the pixel units of sampled images represent an amount of object represented by pixel units of an image having a lowest resolution.

14. (New) The apparatus claimed in claim 3, wherein the conversion means interpolates images such that the pixel units of interpolated images represent an amount of object represented by pixel units of an image having a highest resolution.

15. (New) The apparatus claimed in claim 7, wherein the conversion unit samples images such that the pixel units of sampled images represent an amount of object represented by pixel units of an image having a lowest resolution.

16. (New) The apparatus claimed in claim 7, wherein the conversion unit interpolates images such that the pixel units of interpolated images represent an amount of object represented by pixel units of an image having a highest resolution.

17. (New) The apparatus claimed in claim 8, wherein the conversion unit samples images such that the pixel units of sampled images represent an amount of object represented by pixel units of an image having a lowest resolution.